

## 2.2 Forestry

### 2.2.1 Introduction

The California State Water Resources Control Board (SWRCB), California Coastal Commission (CCC), and other State agencies have identified 12 management measures to address various phases of forestry operations relevant to controlling nonpoint sources of pollution that affect State waters. The forestry management measures are for the most part a system of practices used and recommended by the Board of Forestry and Department of Forestry and Fire Protection in rules or guidance. Associated with each management measure are management practices that are designed to reduce the quantities of pollutants entering receiving waters. Forestry management practices are harvest and engineering techniques that help reduce nonpoint source (NPS pollution). Those who own and harvest the land are responsible for implementation of the management measures and management practices to minimize water quality impairment. Management practices that protect water quality are required by the California Forest Practice Rules. Many rules are specific to the regions or counties where forest management occurs. A registered professional forester can be of great assistance in navigating local regulations and developing a timber harvest plan. A fact sheet has been prepared for each management measure to inform readers of the programs, resources, and case studies specific to California and the management measure.

#### Forestry Category Links:

- [Preharvest Planning](#)
- [Streamside Management Areas](#)
- [Road Construction/Reconstruction](#)
- [Road Management](#)
- [Timber Harvesting](#)
- [Site Preparation and Forest Regeneration](#)
- [Fire Management](#)
- [Revegetation of Disturbed Areas](#)
- [Forest Chemical Management](#)
- [Wetlands Forest Management](#)
- [Postharvest Evaluation](#)
- [Education/Outreach](#)

Silviculture contributes approximately 3 to 9 percent of NPS pollution to the nation's waters. This figure can be higher in some watersheds where silviculture is a major economic activity. Without adequate controls, forestry operations may degrade the characteristics of waters that receive drainage from forestlands. For example, sediment concentrations can increase because of accelerated erosion, water temperatures can increase because of removal of overstory riparian shade, dissolved oxygen can be depleted because of the accumulation of slash and other organic debris, and concentrations of organic and inorganic chemicals can increase because of harvesting and fertilizers and pesticides.

The NPS pollutant of greatest concern with respect to forestry activities is sediment. The potential for sediment delivery to streams from almost all timber-harvesting activities and from forest roads regardless of their level of use or age is a long-term concern. Other pollutants of significance, including nutrients, toxic chemicals and metals, organic matter, pathogens, herbicides, and pesticides, are also of concern; problems associated with these other pollutants and increases in temperature generally do not extend beyond 2 years from the time of harvest or are associated with a specific activity, such as an herbicide application. Nevertheless, all of these pollutants have the potential to affect water quality and aquatic habitat. Minimizing their delivery to surface water and ground water deserves serious consideration before and during forestry activities. Forest harvesting can also affect the hydrology of a watershed, and hydrologic alterations within a watershed have the potential to degrade water quality and adversely affect wetlands.

The California *Management Measures for Polluted Runoff* defines the 12 forestry management measures as follows:

- **2A. Preharvest Planning.** Pursuant to Management Measure 2A, silvicultural activities should be planned to reduce potential delivery of pollutants to surface waters. Components of Management Measure 2A address aspects of forestry operations, including the timing, location, and design of harvesting and road construction; site preparation; identification of sensitive or high-erosion risk areas; and the potential for cumulative water quality impacts.
- **2B. Streamside Management Areas (SMAs).** SMAs protect against soil disturbance and reduce sediment and nutrient delivery to waters from upland activities. Management Measure 2B is intended to safeguard vegetated buffer areas along surface waters to protect the water quality of adjacent streams.
- **2C. Road Construction/Reconstruction.** Pursuant to Management Measure 2C, road construction/reconstruction should be conducted so as to reduce sediment generation and delivery. This can be accomplished by, among other means, following preharvest plan layouts and designs for road systems, incorporating adequate drainage structures, properly installing stream crossings, avoiding road construction in SMAs, removing debris from streams, and stabilizing areas of disturbed soil such as road fills.
- **2D. Road Management.** Management Measure 2D describes how to manage roads to prevent sedimentation, minimize erosion, maintain stability, and reduce the risk that drainage structures and stream crossings will fail or become less effective. Components of this measure include inspections and maintenance actions to prevent erosion of road surfaces and to ensure the effectiveness of stream-crossing structures. They also address appropriate methods for closing roads that are no longer in use.
- **2E. Timber Harvesting.** Management Measure 2E addresses skid trail location and drainage, management of debris and petroleum, and proper harvesting in SMAs. Timber harvesting practices that protect water quality and soil productivity also have economic benefits by reducing the length of roads and skid trails, reducing equipment and road maintenance costs, and providing better road protection.
- **2F. Site Preparation and Forest Regeneration.** Impacts of mechanical site preparation and regeneration operations—particularly in areas that have steep slopes or highly erodible soils, or where the site is located in close proximity to a water body—can be reduced by confining runoff onsite. Management Measure 2F addresses keeping slash material out of drainageways, operating machinery on contours, timing of activities, and protecting ground cover in ephemeral drainage areas and SMAs. Careful regeneration of harvested forestlands is important in protecting water quality from disturbed soils.
- **2G. Fire Management.** Prescribed fire practices for site preparation and methods to suppress wildfires should, as feasible, be conducted in a manner that limits loss of soil organic matter and litter and that reduces the potential for runoff and erosion. Prescribed fires that remove forest litter down to mineral soil on steep slopes or adjacent to streams are most likely to affect water quality.
- **2H. Revegetation of Disturbed Areas.** Management Measure 2H addresses the rapid revegetation of areas disturbed during timber harvesting and road construction—particularly areas within harvest units or road systems where mineral soil is exposed or agitated (e.g., road cuts, fill slopes, landing surfaces, cable corridors, or skid trails) with special priority for SMAs and steep slopes near drainageways.

- **2I. Forest Chemical Management.** Application of pesticides, fertilizers, and other chemicals used in forest management should not lead to surface water contamination. Pesticides must be properly mixed, transported, loaded, and applied, and their containers disposed of properly. Fertilizers must also be properly handled and applied since they also may be toxic depending on concentration and exposure. Components of Management Measure 2I include applications by skilled workers according to label instructions, careful prescription of the type and amount of chemical to be applied, use of buffer areas for surface waters to prevent direct application or deposition, and spill contingency planning.
- **2J. Wetlands Forest Management.** Forested wetlands provide many beneficial water quality functions and provide habitat for aquatic life. Activities in wetland forests should be conducted to protect the aquatic functions of forested wetlands.
- **2K. Postharvest Evaluation.** The goals of Management Measure 2K are to incorporate postharvest monitoring, including (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.
- **2L. Education/Outreach.** The goals of Management Measure 2L are to implement pollution prevention and education programs to reduce NPS pollutants generated by applicable silvicultural activities.

## 2.2.2 General Resources

There are several federal and State agencies and programs that can provide general information to promote sustainable forestry practices and prevent NPS pollution from entering receiving waters. The agencies and programs listed below can provide assistance and information for all 12 management measures. Resources specific to each of the forestry management measures can be found on the corresponding fact sheet.

- **Contact a Forest Advisor** to help with understanding local regulations and developing a timber management plan (<http://www.fire.ca.gov/ResourceManagement/PDF/ForestAdvisorList.pdf>).
- **California Forest Stewardship Program** (<http://ceres.ca.gov/foreststeward/index.html>): This program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners.
- **Forest Stewardship Helpline** (Telephone: 1-800-738-TREE): This helpline can answer questions and provide referrals on any forest-related topic.
- **California Forest Improvement Program** (<http://www.fire.ca.gov/ResourceManagement/CFIP.asp>): The purpose of the California Forest Improvement Program (CFIP) program is to encourage private and public investment in, and improved management of, California's forestlands and resources. This focus is to ensure adequate high-quality timber supplies; related employment and other economic benefits; and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations. For more information, download the **California Forest Improvement Program, Users Guide** (<http://www.ceres.ca.gov/foreststeward/html/CFIP.html#Anchor-Download-18066>).
- **California Department of Forestry and Fire Protection's Fire and Resource Assessment Program (FRAP)** (<http://frap.cdf.ca.gov/index.htm>): FRAP assesses the amount and extent of

California's forests and rangelands, analyzes their conditions, and identifies alternative management and policy guidelines. FRAP has published *The Changing California Forest and Range Assessment 2003*, which provides a systematic overview of the status, trends, and challenges to California's forest and rangeland resources.

- **USDA NRCS *National Forestry Handbook* and *National Forestry Manual*** (<http://soils.usda.gov/technical/nfhandbook/> and <http://soils.usda.gov/technical/nfmanual/>): The handbook and manual provide information for USDA NRCS personnel on forest planning and harvesting on nonpublic lands. The manual has information on the USDA NRCS Forest Policy.
- **North Coast Regional Water Quality Control Board (RWQCB)** (<http://www.swrcb.ca.gov/rwqcb1/programs/timber.html>): The North Coast RWQCB has been active in regulating discharges from logging, construction, and associated activities since 1972. Implementation of the Forest Practice Rules, which affect timber harvesting near streams, has a direct influence on water quality throughout the North Coast Region. The RWQCB staff perform regulatory activities including pre- and post-harvest inspections, watershed analysis, stream monitoring, and TMDL development.
- **California Department of Fish and Game** (<http://www.dfg.ca.gov/>): The Department of Fish and Game provides information and recommendations to private landowners on programs and activities for the protection, management, and enhancement of native wildlife, fish, plants, and habitats. A variety of programs and partnerships between the State and private landowners are available. These initiatives could include timber management in the context of improving wildlife habitat.
- **USDA Forest Service** (<http://www.fireplan.gov/>): The USDA Forest Service is working toward goals of the National Fire Plan to put information, materials, and funds in the hands of local organizations and communities. The State Fire Assistance program, with \$3.6 million for California, helps build an optimal level of state firefighting capability, supports training and equipment for state firefighters, funds hazard mitigation projects on state and local land, and promotes Firewise training so homeowners can create defensible space and reduce fire risk around their homes and in their communities.
- **USEPA, Nonpoint Source News-Notes** (<http://www.epa.gov/owow/info/NewsNotes/>): Nonpoint Source News-Notes is an online bulletin published by EPA that covers a wide range of topics, including nonpoint source pollution control, watershed restoration, and ecosystem-driven management. The Web interface allows users to search current and back issues of News-Notes by keyword.
- **The Center for Watershed Protection (CWP), *Urban Watershed Forestry Manual*** (<http://www.cwp.org/forestry/index.htm>): The Center for Watershed Protection (CWP), in cooperation with the USDA Forest Service, Northeastern Area State and Private Forestry Branch, is producing a three-part manual series on using trees to protect and restore urban watersheds. This manual provides information on methods for increasing forest cover in a watershed; specific ways to enable developers, engineers, or landscape architects to incorporate more trees into a development site; and detailed guidance on urban tree planting at both the development site and the watershed scale. Parts 1 and 2 of the manual are available for download at this Web site.
- **USEPA, National Management Measures to Control Nonpoint Source Pollution from Forestry** (<http://www.epa.gov/owow/nps/forestrymgmt/pdf/guidance.pdf>): This document serves as a technical guidance and reference manuscript for use by State, territory, and authorized tribal managers and the public regarding the implementation of NPS pollution management measures from forestry activities. The manual covers NPS pollution activities related to forestry, water

quality effects as a result of forestry pollutants, and management measures or mechanisms to control NPS pollution. Guidance from this document is applicable to both inland and coastal areas but does not address all practices and techniques specific to local or regional soils, climates, or forest types.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

### 2.2.3 Management Measure 2A Preharvest Planning

*Management Measure*

1. Perform advance planning for forest harvesting that includes the following elements where appropriate:

Element 1. Identify (a) the area to be harvested including the location of water bodies and sensitive areas such as wetlands, threatened or endangered aquatic species habitat areas, or high-erosion-hazard areas (landslide-prone areas) within the harvest unit; and (b) the hydrologic unit where the project is located and the water bodies that the project is tributary to.

Element 2. Time the activity for the season or moisture conditions to avoid degradation of water quality and prevent impacts on beneficial uses. Avoid any activities that cause soil disturbance or discharge from road surfaces during wet weather, except emergency maintenance work.

Element 3. Consider potential water quality impacts and erosion and sedimentation control in the selection of silviculture and regeneration systems, especially for harvesting and site preparation.

Element 4. Reduce the risk of landslides and severe erosion by identifying high-erosion-hazard areas and avoiding timber operations where they may exacerbate risk.

Element 5. Consider cumulative effects from timber operations or roads on any known existing water quality impairments or problems in watersheds.

2. Perform advance planning for forest road systems that includes the following elements where appropriate:

Element 1. Locate and design road systems to minimize potential sediment generation and delivery to surface waters. Key activities are (a) locate roads, landings, and skid trails to avoid steep grades and steep or unstable hillslope areas, and to decrease the number of stream crossings; (b) avoid to the extent practicable locating new roads and landings in Streamside Management Areas (SMAs); and (c) determine road usage and select the appropriate road standard.

Element 2. Locate and design temporary and permanent stream crossings to prevent failure and control impacts from the road system. Key activities are (a) size, design, and site crossing structures to prevent failure and minimize diversion potential; and (b) design crossings to facilitate fish passage in fish-bearing streams.

Element 3. Ensure that the design of the road prism and the road surface drainage is appropriate to the terrain and that road surface design is consistent with the road drainage structures.

Element 4. Use suitable materials for surface roads planned for all-weather use to support truck traffic.

Element 5. Design road systems to avoid high erosion or landslide hazard areas. Identify these areas and consult a qualified specialist for the design of any roads that must be constructed in these areas.



### 2.2.3.1 Programs

The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever. The Timber Harvesting Plan (THP) is the blueprint submitted by a landowner to CDF outlining what timber they want to harvest, how it will be harvested, and the steps that will be taken to prevent damage to the environment. CDF reviews and approves THPs (<http://www.fire.ca.gov/ResourceManagement/THinCA.asp>).

### 2.2.3.2 Management Practices

A Timber Harvest Plan must be prepared and submitted to the regional CDF director before timber is harvested for commercial purposes. A Registered Professional Forester (RPF) usually prepares a THP. The RPF preparing the plan will submit to the Director, with the plan, a Notice of Intent to Harvest Timber (Notice of Intent) under a number of circumstances where the timber harvest could have an effect on neighboring property or downstream water bodies (CDF, 2003, Article 2 and sections 1032-1037 of the California Forest Practice Rules). In addition to a Notice of Intent, a Cumulative Watershed Effects (CWE) analysis is now required as part of THPs in California. In evaluating cumulative impacts, the RPF considers factors such as the watershed(s) in which the site is located; soil productivity; biological, recreational, and visual resources; and traffic. Specific watershed factors to be addressed are sediment, water temperature, organic debris, chemical contamination, and peak flow. The CDF, as lead agency, makes the final determination regarding assessment sufficiency and the presence or absence of significant cumulative impacts. This determination is based on a review of all sources of information provided and developed during review of the THP (CDF, 2003).

There are numerous factors that should be considered when developing THPs and CWEs, but in general a thorough evaluation of the site should identify areas that require special protection, such as land adjacent to watercourses, steep slopes with high erosion potential, natural springs, wetlands, and areas that could provide habitat for endangered species. Site features to be protected and other considerations for developing THPs and CWEs are outlined in detail in USEPA's draft *National Management Measures to Control Nonpoint Source Pollution From Forestry* (USEPA, 2002), which can be downloaded in PDF format from <http://www.epa.gov/owow/nps/forestrymgmt/> (see Chapter 3, Section 3A Preharvest Planning).

### 2.2.3.3 Information Resources

- **California Licensed Foresters Association**  
([http://www.clfa.org/what\\_is\\_a\\_registered\\_professiona.htm](http://www.clfa.org/what_is_a_registered_professiona.htm)): This Web site has information about contacting professional foresters.
- **California Forest Practice Act**  
(<http://www.fire.ca.gov/ResourceManagement/pdf/2000RULE198254.pdf>): The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever.
- **California Forest Practice Rules**  
(<http://www.fire.ca.gov/ResourceManagement/pdf/FPR200301.pdf>): The purpose of the Forest Practice Rules is to implement the provisions of the Forest Practice Act of 1973. The rules ensure that forestry practices are consistent with environmental quality programs in the State.

- **California Department of Forestry and Fire Protection, *CDF's Role in Timber Harvesting*** (<http://www.fire.ca.gov/ResourceManagement/pdf/CDFSROLE2002.pdf>): This fact sheet describes CDF's role in timber harvesting, and the review and approval of Timber Harvest Plans.
- **FishXing Web site** (<http://www.stream.fs.fed.us/fishxing/index.html>): This Web site provides software and learning systems for calculating fish passage through culverts (USEPA, 2002).
- **The USDA Forest Service's Roads Analysis Procedure** ([http://www.fs.fed.us/r6/columbia/roads\\_analysis/roads\\_analysis\\_process\\_handbook.pdf#xml](http://www.fs.fed.us/r6/columbia/roads_analysis/roads_analysis_process_handbook.pdf#xml)): This procedure is designed to help national forest managers bring their road systems into balance with current social, economic, and environmental needs (USDA Forest Service, 1999). Roads Analysis uses a six-step procedure with a set of analytical questions to be used in tailoring analysis techniques to individual situations. Roads analysis is primarily a stand-alone procedure, but the conceptual framework and resources for analysis may be readily integrated into any analytical process in which the roads are examined.

#### 2.2.3.4 Case Study

*The Caspar Creek Experimental Watershed Study.* This watershed study on the Jackson Demonstration State Forest near Fort Bragg, California, is a cooperative venture of the Redwood Sciences Laboratory and the California Department of Forestry and Fire Protection. The study has been conducted continuously since 1962. The research focus is on learning more about how watersheds respond to logging. Research data on hydrology and sedimentation are available on the laboratory's Web site (<http://www.fs.fed.us/psw/topics/water/caspar/>).

#### 2.2.3.5 References

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- USDA Forest Service. 1999. *Roads Analysis: Informing Decisions About Managing the National Forest Transportation System*. Miscellaneous Report FS-643. USDA Forest Service, Washington, DC.



**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## 2.2.4 Management Measure 2B Streamside Management Areas

### *Management Measure*

1. Establish and maintain a Streamside Management Area (SMA) along surface waters that is sufficiently wide and includes a sufficient number of canopy species to serve as a buffer against detrimental changes in the temperature regime of the water body, to provide bank stability, and to withstand wind damage.
2. Manage the SMA, including flood-prone areas, in such a way as to protect against soil disturbance in the SMA and delivery to the stream of sediments and nutrients generated by forestry activities, including harvesting.
3. Manage the SMA canopy species to provide a sustainable source of large woody debris needed for instream channel structure and aquatic species habitat.

### 2.2.4.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of all of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrc-mgt.php>).

Although SMAs can protect water quality, leaving timber for an SMA results in less timber harvested from the stand. Dykstra and Froehlich (1976) calculated that, in an Oregon timber sale, leaving an SMA 55 feet wide resulted in a 0 to 6 percent timber volume forgone per million board feet of timber. Likewise an SMA 150 feet wide resulted in 6 to 17 percent timber volume forgone.

### 2.2.4.2 Management Practices

Under the California Forest Practice Rules, SMAs are called Watercourse and Lake Protection Zones (WLPZs). A Registered Professional Forester (RPF) preparing the Timber Harvest Plan (THP) should conduct a field examination of all lakes and watercourses and map all lakes and watercourses that occur in the vicinity of the planned harvest.

The following are general practices that can be used to establish SMAs:

- *Evaluate sensitive conditions:* Evaluate areas near, and areas with the potential to directly impact, watercourses and lakes for sensitive conditions including existing and proposed roads, skid trails and landings, unstable and erodible watercourse banks, unstable upslope areas, debris, jam potential, inadequate flow capacity, changeable channels, overflow channels, flood prone areas, and riparian zones.

- *Spawning/rearing habitat:* Map the location of spawning and rearing habitat for anadromous salmonids, and evaluate the condition of the habitat using habitat typing that, at a minimum, identifies the pool, flatwater, and riffle percentages.
- *Establish a Watercourse and Lake Protection Zone:* Determine the required width of the WLPZ according to the guidelines in California Forest Practice Rules. WLPZs vary between 50 and 150 feet depending on the steepness of the terrain and the class of the watercourse the WLPZ is designed to protect.
  - *Protect vegetation in the WLPZ:* Within the WLPZ, retain at least 75 percent surface cover and undisturbed area to act as a filter strip, for raindrop energy dissipation, and for wildlife habitat. Mark trees in WLPZs before other preharvest activities begin to ensure retention of the shade canopy filter strip properties of the WLPZ and the maintenance of a multi-storied stand to protect water quality values. Provide for future large woody debris for instream habitat by retaining at least two living conifers per acre at least 16 inches diameter breast high and 50 feet tall within 50 feet of perennial streams.
  - *Protect soils in WLPZs to prevent erosion:* Treat exposed mineral soil in the WLPZ adjacent to perennial streams with mulch, riprap, grass seed, or chemical soil stabilizers to reduce soil loss. This does not apply to the traveled surface of roads. Where necessary to protect beneficial uses of water from timber operations, use protection measures such as seeding, mulching, or replanting to retain and improve the natural ability of the ground cover within the standard width of the WLPZ to filter sediment, minimize soil erosion, and stabilize banks of watercourses and lakes.
- *Establish an Equipment Limitation Zone:* Where operations occur adjacent to certain watercourses, designate an Equipment Limitation Zone (ELZ) where required by the California Forest Practice Rules. Excluding heavy equipment from streamside areas helps to prevent soil disturbance, erosion, and sedimentation in streams.

#### 2.2.4.3 Information Resources

- **Southern California National Forest Management Plan Revisions** (<http://www.sw-center.org/swcbd/Programs/forests/so-cal-forest-plans.html>): The 400-plus page Conservation Alternative is a scientifically based forest management plan that emphasizes the value of preserving species, ecosystems, habitat, watersheds, and wilderness as well as maintaining opportunities for low-impact recreation in the most highly visited national forests in the nation.
- **Department of Forestry and Research, Mississippi State University, Streamside Management Zones (SMZs)** (<http://www.cfr.msstate.edu/fwrc/forestry/streamside.htm>): The Departments of Forestry and Wildlife and Fisheries embarked on a project designed to evaluate the effectiveness of SMZs in protecting the water quality and habitat that support fish and macroinvertebrate populations in 15 streams in north-central Mississippi.

#### 2.2.4.4 Case Study

*The Use of Alternative Buffers and Filter Strips in Oregon.* The costs associated with the use of alternative buffers and filter strips were analyzed in an Oregon study (Olsen, 1987). In that study, increasing the SMA width from 35 feet on each side of a stream to 50 feet reduced the value per acre by \$75 (discounted cost) to \$103 (undiscounted cost), or an approximate 2 percent increase in harvesting cost per acre (from \$3,163 discounted to \$5,163 undiscounted). Doubling the SMA width from 35 to 70 feet on each side of a stream reduced the dollar value per acre by approximately three times, adding approximately 8 percent to the discounted harvesting costs (USEPA, 2002).

**2.2.4.5 References**

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- Dykstra, D.P., and Froehlich, H.A. 1976. Costs of Stream Protection During Timber Harvest. *Journal of Forestry* 74(10): 684-687.
- Olsen, E.D. 1987. A Case Study of the Economic Impact of Proposed Forest Practices Rules Regarding Stream Buffer Strips on Private Lands in the Oregon Coast Range. In *Managing Oregon's Riparian Zone for Timber, Fish and Wildlife*, NCASI Technical Bulletin No. 514, pp. 52-57.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## 2.2.5 Management Measure 2C Road Construction/Reconstruction

### *Management Measure*

1. Follow preharvest planning (as described under Management Measure 2A) when constructing or reconstructing roadways.
2. Follow designs planned under Management Measure 2A for road surfacing and shaping.
3. Install road drainage structures according to designs planned under Management Measure 2A and regional storm return period and installation specifications. Match these drainage structures with terrain features and with road surface and prism designs.
4. Guard against the production of sediment when installing stream crossings.
5. Protect surface waters from slash and debris material from roadway clearing.
6. Use straw bales, silt fences, mulching, or other favorable practices on disturbed soils on cuts, fill, etc.
7. Avoid constructing new roads in SMAs to the extent practicable.

### 2.2.5.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrc-mgt.php>).

The USDA Forest Service adopted a new road management policy in January 2001, which directs the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. The policy includes a science-based roads analysis process designed to help managers make better decisions on roads. The USDA Forest Service is looking at ways to make the road management policy work better and is conducting an internal review of the policy ([http://www.fs.fed.us/eng/road\\_mgt/index.shtml](http://www.fs.fed.us/eng/road_mgt/index.shtml)).

### 2.2.5.2 Management Practices

Logging roads and landings have the potential to be one of the greatest sources of sediment from managed forestlands. According to the California Forest Practice Rules, all logging roads and landings in the logging area need to be planned, located, constructed, reconstructed, used, and maintained in a manner that is consistent with long-term enhancement and maintenance of the forest resource and that prevents degradation of water quality.

Existing roads should be used whenever possible and new roads should be laid out in systematic patterns to reduce overall mileage. To reduce disturbance to natural site features, new roads should be tailored to the natural topography and should not be placed in unstable areas that are subject to erosion or deterioration, such as near canyon bottoms or through wetlands. Ideally they would be located on natural benches, flatter slopes, and areas of stable soils to minimize effects on watercourses.

### 2.2.5.3 Information Resources

- **California Forest Stewardship Program. *Proper Road Design Minimized Stream Impacts*** (<http://ceres.ca.gov/foreststeward/html/roads.html>): This fact sheet provides information on properly designing forest roads.
- **California Forest Stewardship Program. *Preparing Your Road for Rain*** (<http://ceres.ca.gov/foreststeward/html/prepare.html>): This fact sheet provides information on reducing runoff pollution from forest roads.
- **USDA Forest Service, Road Management Policy** ([http://www.fs.fed.us/eng/road\\_mgt/policy.shtml](http://www.fs.fed.us/eng/road_mgt/policy.shtml)): In 2001, the USDA Forest Service published a final policy governing the national forest transportation system. This Web site provides links to the policy and interim direction revising the policy.
- **Geomorphic Impacts of Culvert Replacement and Removal** (<http://www.clfa.org/CulvertReplacementGuidelines21103.pdf>): These guidelines are used by the U.S. Fish and Wildlife Service in culvert replacement and removal projects, and are recommended practices for the design and construction of stream crossings. These guidelines serve to assist with any culvert-related endangered species consultation requirements. Compliance with these guidelines should help minimize or avoid impacts during project construction activities and result in long-term benefits to threatened or endangered species.
- **SEDMODL** ([http://frap.cdf.ca.gov/projects/nchip\\_sediment/abstractframes.html](http://frap.cdf.ca.gov/projects/nchip_sediment/abstractframes.html)): Previous studies in forested watersheds in northern California have shown that the location and condition of road within a watershed can have a significant effect on the amount of erosion associated with the road system. A road sedimentation model, SEDMODL, was applied to the Caspar Creek watershed on the Jackson Demonstration State Forest. The model was run on Caspar Creek to evaluate the contribution of roads as part of the basin's sediment budget and to assist in identifying roads that produce relatively high amounts of sediment.
- **Mendocino County Resource Conservation District, *Handbook for Forest and Ranch Roads***. (June 1994). This document is a guide and field manual for anyone involved with roads in forests or on ranches. It contains many helpful photographs and illustrations, charts, and tips on approaching road building from planning through construction, maintenance, and closure. The publication can be requested by calling the Mendocino County Resource Conservation District (Telephone: 707-468-9223).

### 2.2.5.4 Case Study

*Fisher Creek Watershed Improvement Project.* As part of this project in the Payette National Forest, Idaho, Rygh (1990) examined the costs of ripping and scarification using different techniques and specifically compared the relative advantages of using track hoes for ripping and scarification versus using large tractor-mounted rippers. Track hoes were found to be preferable to tractor-mounted rippers for a variety of reasons, including the following:

- A reduction in furrows and resulting concentrated runoff caused by tractors
- Improved control over the extent of scarification
- Increased versatility and maneuverability of track hoes
- Cost savings

The study concluded that the cost of ripping with track hoes ranged from \$406 to \$506 per mile compared with \$686 per mile for ripping with D7 or D8 tractors (1998 dollars).

#### **2.2.5.5 References**

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Rygh, J. 1990. *Fisher Creek Watershed Improvement Project Final Report*. Payette National Forest, ID.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## 2.2.6 Management Measure 2D Road Management

### *Management Measure*

1. Avoid using roads for timber hauling or heavy traffic during wet or thaw periods on roads not designed and constructed for these conditions.
2. Evaluate the future needs for a road and close roads that will not be needed. Leave closed roads and drainage channels in a stable condition to withstand storms.
3. Remove drainage crossings and culverts if there is a reasonable risk of plugging or failure from lack of maintenance.
4. After harvest, close and stabilize temporary spur roads and seasonal roads to control and direct water away from the roadway. Remove all temporary stream crossings.
5. Inspect roads to determine the need for structural maintenance. Conduct maintenance practices, when conditions warrant, including cleaning and replacement of deteriorated structures and erosion controls, grading or seeding of road surfaces and, in extreme cases, slope stabilization or removal of road fills where necessary to maintain structural integrity.
6. Conduct maintenance activities, such as dust abatement, so that contaminants or pollutants are not introduced into surface waters.
7. Properly maintain permanent stream crossings and associated fills and approaches to reduce the likelihood (a) that stream overflow will divert onto roads, and (b) that fill erosion will occur if the drainage structures become obstructed.

### 2.2.6.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrsrc-mgt.php>).

The USDA Forest Service adopted a new road management policy in January 2001, which directs the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. The policy includes a science-based roads analysis process designed to help managers make better decisions on roads. The USDA Forest Service is looking at ways to make the road management policy work better and is conducting an internal review of the policy ([http://www.fs.fed.us/eng/road\\_mgt/index.shtml](http://www.fs.fed.us/eng/road_mgt/index.shtml)).



### 2.2.6.2 Management Practices

Sound planning, design, and construction measures often reduce road maintenance needs after construction. Minimum maintenance is required of roads constructed with a minimum width in stable terrain and with frequent grade reversals or dips. Unfortunately, older roads remain one of the greatest sources of sediment from managed forestlands. After harvesting, roads are often forgotten, and erosion problems might go unnoticed until after severe resource damage has occurred (USEPA, 2002)

The following are practices that can be used to minimize the adverse environmental impact of logging roads:

- *Prescribed maintenance:* At a minimum of once per year, prescribed maintenance should be performed to control erosion on permanent, seasonal roads, landings, and drainage structures that are not abandoned.
- *Abandonment of temporary roads:* Temporary roads and associated landings should be abandoned upon completion of timber operations in accordance with existing CDF regulations.
- *Bridges, drainage structures, and berms:* Bridges and drainage structures should be kept open to the unrestricted passage of water. Drainage structures not adequate to carry water from the 50-year flood level should be removed in accordance with CDF regulations by the first day of the winter period before the flow of water exceeds their capacity if operations are conducted during the winter period, or by the end of timber operations (whichever occurs first). Properly functioning drainage structures on roads that existed before timber operations need not be removed (CDF, 2003). Trash racks or similar devices can be installed where needed at culvert inlets in a manner that minimizes culvert blockage. Roadside berms should be removed from logging roads or breached before the beginning of the winter period, except where needed to control erosion. Drainage ditches should be maintained to allow free flow of water and minimize soil erosion. Each drainage structure and trash rack should be maintained and repaired as needed to prevent blockage and to provide adequate carrying capacity. Where not present, new trash racks can be installed if there is evidence that woody debris is likely to significantly reduce flow through a drainage structure.
- *Stable road surfaces:* Road surfaces should be treated as necessary during timber operations to prevent excessive loss of road surface materials using methods such as rocking, watering, chemically treating, asphaltting, or oiling.
- *Slope protection:* Actions should be taken to prevent failures of cut, fill, or sidecast slopes. This may involve installing or renewing soil stabilization treatments on road or landing cuts, fills, or sidecast slopes when such treatment could minimize surface erosion that threatens the beneficial uses of water (CDF, 2003).

### 2.2.6.3 Information Resources

- **USDA Forest Service Roads Analysis: Informing Decisions About Managing the National Forest Transportation System** ([http://www.fs.fed.us/eng/road\\_mgt/DOCSroad-analysis.shtml](http://www.fs.fed.us/eng/road_mgt/DOCSroad-analysis.shtml)): This is a complete science-based roads analysis designed to inform management decisions about the benefits and risks of constructing new roads in unroaded areas; relocating, stabilizing, changing the standards of, or decommissioning, unneeded roads; access issues; and increasing, reducing, or discontinuing road maintenance.
- **California Forest Stewardship Program. Preparing Your Road for Rain** (<http://ceres.ca.gov/foreststeward/html/prepare.html>): This fact sheet provides information on reducing runoff pollution from forest roads.

- **California Forest Stewardship Program. Road Retirement** (<http://ceres.ca.gov/foreststeward/html/unneeded.html>): This fact sheet provides information on how to properly close forest roads.
- **SEDMODL** ([http://frap.cdf.ca.gov/projects/nchip\\_sediment/abstractframes.html](http://frap.cdf.ca.gov/projects/nchip_sediment/abstractframes.html)): Previous studies in forested watersheds in northern California have shown that the location and condition of a road within a watershed can have a significant effect on the amount of erosion associated with the road system. A road sedimentation model, SEDMODL, was applied to the Caspar Creek watershed on the Jackson Demonstration State Forest. The model was run on Caspar Creek to evaluate the contribution of roads as part of the basin's sediment budget and to assist in identifying roads that produce relatively high amounts of sediment.
- **Mendocino County Resource Conservation District, Handbook for Forest and Ranch Roads.** This document is a guide and field manual for anyone involved with roads in forests or on ranches. It contains many helpful photographs and illustrations, charts, and tips on approaching road building from planning through construction, maintenance, and closure. This publication can be requested by calling the Mendocino County Resource Conservation District (Telephone: 707-468-9223).
- **USDA Forest Service, Water/Road Interaction Technology Series** (<http://www.stream.fs.fed.us/water-road/>): This series offers an excellent discussion of the relationship between forest roads and drainage.

#### 2.2.6.4 Case Study

*Road Decommissioning.* Abandoning roads without first performing corrective measures can create erosion problems that persist for decades. When a road is no longer needed, it can be restored to a more natural state by removing road improvements and reestablishing vegetation in a process called decommissioning. Road decommissioning can significantly reduce water quality effects from unused roads, and road closure and decommissioning can help realize many objectives and purposes (Harr and Nichols, 1993), including the following:

- Eliminate or discourage access to roads to reduce maintenance expenditures.
- Eliminate the potential for drainage structure failure and stream diversion.
- Reduce soil loss, embankment washout, mass wasting, failures, slides, slumps, sedimentation, turbidity, and damage to fish habitat.
- Provide cover and organic matter to soil, and improve the quality of wildlife and fish habitat.
- Enhance the visual qualities of road corridors and disturbed areas.
- Attempt to restore the natural pre-road hydrology to the site.

Road decommissioning can lead to improvements in fish habitats where sediment-laden runoff from old forest roads enters streams. The practice was used in a watershed in northwest Washington as part of watershed rehabilitation to improve fish habitats and water quality and to reduce flood hazards. On unused, 30- to 40-year-old, largely impassable roads and landings, fills were stabilized, stream crossings were removed, slopes were recontoured, and drainage patterns were reestablished at an average cost of \$3,950 per kilometer (with a range of \$1,500 to \$7,500 per kilometer) (1998 dollars). Costs were lowest where little earthmoving was involved; costs were higher where a lot of brush had to be cleared away and sidecast material had to be pulled upslope, and highest where fills were removed at stream crossings and landings. Afterward, however, the obliterated roads and landings sustained much less damage from storms than unused roads that were not obliterated (Harr and Nichols, 1993).

### 2.2.6.5 References

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- Harr, R.D., and R.A. Nichols. 1993. Stabilizing forest roads to help restore fish habitats: A northwest Washington example. *Fisheries* 18(4): 18-22.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

## 2.2.7 Management Measure 2E Timber Harvesting

### *Management Measure*

The timber harvesting management measure consists of implementing the following:

#### 1. General

Element 1. Conduct timber harvesting operations with skid trails or cable yarding following layouts determined under Management Measure 2A.

Element 2. Install landing drainage structures to minimize erosion and prevent sedimentation.

Element 3. Construct landings away from steep slopes and reduce the likelihood of fill slope failures. Protect landing surfaces used during wet periods. Locate landings outside Streamside Management Areas (SMAs).

Element 4. Protect stream channels and significant ephemeral drainages from logging debris and slash material.

Element 5. Use appropriate areas for petroleum storage and equipment maintenance and service. Establish procedures to contain and treat spills. Recycle or properly dispose of all waste materials.

#### 2. For cable yarding

Element 1. Limit yarding corridor gouge or soil plowing by properly locating cable yarding landings.

Element 2. Locate corridors for SMAs following Management Measure 2B.

#### 3. For groundskidding

Element 1. Within SMAs, operate ground-skidding equipment only at stream crossings. In SMAs, fell and endline trees to avoid sedimentation and damage to residual vegetation.

Element 2. Use improved stream crossings for skid trails that cross flowing drainages. Construct skid trails to disperse runoff and with adequate drainage structures.

Element 3. On steep slopes, use cable systems rather than ground-skidding where ground-skidding may cause excessive erosion.

### 2.2.7.1 Programs

The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever (<http://www.fire.ca.gov/ResourceManagement/THinCA.asp>).

The USDA Forest Service's National Forest Timber Harvest must conform to the 1976 National Forest Management Act (NFMA). The NFMA requires that each national forest develop a comprehensive plan, using substantial public involvement and sound science, to guide future management. Many national forests are now working to revise those plans by addressing inadequacies, new information, changed conditions, and/or new issues or trends. More information on forest management in the California National Forests is available at <http://www.fs.fed.us/r5/forests.html>.

### 2.2.7.2 Management Practices

The following are practices that can be used to minimize the adverse environmental impacts of timber harvest:

- *Felling trees:* Trees should be felled in a direction away from watercourses and lakes. Also, damage to desirable residual trees and tree seedlings of commercial species should be avoided during felling and while operating heavy equipment. Slash and debris from timber operations should not be bunched adjacent to residual trees required for silvicultural or wildlife purposes or placed in locations where they could be discharged into a Class I or II watercourse or lake (CDF, 2003).
- *Skidding logs:* Logs should be skidded uphill to log landings whenever possible, and the ends of the logs should be raised to reduce rutting and gouging. This practice disperses water on skid trails away from the landing. Skidding uphill lets water from trails flow onto progressively less-disturbed areas as it moves downslope, reducing the likelihood of erosion. Skidding downhill concentrates surface runoff on lower slopes along skid trails, resulting in significant erosion and sedimentation hazard (USEPA, 2002). If it is not possible to skid uphill, logs should be skidded along the contour (perpendicular to the slope), and skidding should be avoided on slopes greater than 40 percent. Following the contour reduces soil erosion and encourages revegetation. Skid trail layouts that concentrate runoff into draws, ephemeral drainages, or watercourses and skidding up or down ephemeral drainages should be avoided. Endlining, using care to avoid soil plowing or gouging, should be used to winch logs out of SMAs, or, alternatively, trees can be felled directionally so the tops extend out of SMAs, allowing the trees to be skidded without having to operate equipment within the SMAs. Ground skidding should be suspended during wet periods, when excessive rutting and churning of the soil begins, or when runoff from skid trails is turbid and no longer infiltrates within a short distance from the skid trail. Further limitation of ground skidding of logs, or the use of cable yarding, might be needed on slopes where there are sensitive soils and/or during wet periods.
- *Heavy equipment operation:* Tractors should be operated in a manner that complies with CDF regulations. Heavy equipment with a blade should not be operated on skid roads or slopes that are so steep as to require the use of the blade for braking. Heavy equipment should not be used on slopes steeper than 65 percent, slopes steeper than 50 percent where the erosion hazard rating is high or extreme, and slopes over 50 percent that lead without flattening to sufficiently dissipate water flow and trap sediment before it reaches a watercourse or lake. Heavy equipment should also not be used on unstable areas, but if such areas are unavoidable, the Registered Professional Forester (RPF) should develop specific measures to minimize the effect of operations on slope instability.
- *Roads:* Tractor roads should be limited to the minimum necessary extent and width for removal of logs. Existing tractor roads should be used instead of constructing new tractor roads. Where

tractor roads are constructed, timber operators should use tractor roads only, both for skidding logs to landings and on return trips.

- *Spill prevention and waste management:* Equipment used in timber operations should not be serviced in locations where servicing will allow grease, oil, or fuel to pass into lakes or watercourses. Non-biodegradable refuse, litter, trash, and debris resulting from timber operations should be disposed of in a manner approved by State and local authorities. Practices should be implemented that prevent mobilization by rainfall or runoff of pollutants from wastes that are temporarily stored on the site.
- *Cable yarding:* The natural topography and timber types should be used to maximum efficiency so that cable yarding operations protect residual trees. Residual trees required to be left upon completion of timber operations should not be used for rub trees, corner blocks, rigging, or other cable ties unless effectively protected from damage. Tight-lining for the purpose of changing location of cable lines should not be used unless such practice can be carried on without damaging residual trees. Tractors should not be used in areas designated for cable yarding except to pull trees away from streams, to yard logs in areas where deflection is low, to construct firebreaks and/or layouts, and to provide tail-holds. Cabling systems or other systems should be used when ground skidding would expose excess mineral soil and induce erosion and sedimentation. Use high-lead cable or skyline cable systems on slopes greater than 40 percent and on average-profile slopes of less than 15 percent (the latter to avoid soil disturbance from sidewash).

Cable yarding should be avoided in or across watercourses. When cable yarding across streams cannot be avoided, full suspension should be used to minimize damage to channel banks and vegetation in the SMA. Cableways should be cut or cleared across SMAs where SMAs must be crossed. This reduces the damage to trees remaining and prevents trees next to the stream channel from being uprooted.

- *Waterbreaks:* Waterbreaks should be installed on skid trails and tractor roads no later than the beginning of the winter period of the current year of timber operations. If logging occurs during the winter, waterbreaks should be installed before the end of the day if the U.S. Weather Service forecasts a “chance” (30 percent or more) of rain before the next day, and prior to weekends or other shutdown periods. Waterbreaks should be constructed concurrently with the construction of firebreaks and immediately upon conclusion of use of tractor roads, roads, layouts, and landings that do not have permanent and adequate drainage facilities, or drainage structures. Waterbreaks should be cut diagonally a minimum of 15.2 centimeters (cm) (6 inches) into the firm roadbed, cable road, skid trail, or firebreak surface, and a continuous firm embankment of at least 15.2 cm (6 in.) in height should be shaped immediately adjacent to the lower edge of the waterbreak cut. According to California Forest Practice Rules, the maximum permitted distance between waterbreaks is based upon the road gradient and soil erosion hazard rating, and varies from 50 to 300 feet.

Waterbreaks should be located to allow water to be discharged into some form of vegetative cover, duff, slash, rocks, or less erodible material. They should be constructed so that water will be discharged and spread to minimize erosion. Where waterbreaks cannot effectively disperse surface runoff, other erosion controls should be installed as needed to comply with CDF regulations. Waterbreaks or any other erosion controls should be maintained on skid trails, cable roads, layouts, firebreaks, abandoned roads, and site preparation areas during the prescribed maintenance period and during timber operations, or at least once per year. The CDF may

prescribe a maintenance period extending 3 years after timber operations are complete (CDF, 2003).

- *Watercourse crossings:* Watercourse-crossing facilities on tractor roads should be kept to a minimum. A prepared watercourse crossing using a structure such as a bridge, culvert, or temporary log culvert can be used to protect the watercourse from siltation where tractor roads cross a watercourse. Crossings should be designed to allow for the unrestricted passage of all life stages of fish that could be present in the watercourse. Watercourse-crossing facilities on tractor roads not constructed to permanent crossing standards should be removed before the beginning of the winter period.
- *After harvesting:* Skid trails should be retired by installing water bars or other erosion control and drainage devices, removing culverts, and mulching and reseeded. Logging slash should be distributed through the skid trails to supplement the water bars. Cross drains can be built on abandoned skid trails to protect stream channels or side slopes. Logging slash should be distributed throughout skid trails to supplement water bars and seeding to reduce erosion on skid trails.

### 2.2.7.3 Information Resources

- **California Forest Stewardship Program, *Salvage Timber Harvesting Considerations*** (<http://ceres.ca.gov/foreststeward/html/salvage.html>): This fact sheet provides information salvage harvesting.
- **Lolo National Forest, Montana, *Soil and Water Best Management Practices Effectiveness Monitoring Report*** (<http://www.fs.fed.us/r1/lolo/resources-natural/soil-water/monitoring-bmp-rpt/b-toc.pdf>): This document contains fact sheets and case studies for timber harvesting and other forestry management practices.
- **USEPA, *Watershed Academy Web: Forestry Best Management Timber Harvesting*** (<http://www.epa.gov/watertrain/forestry/subel.htm>): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **Wisconsin Department of Natural Resources, *Timber Harvesting*** (<http://www.dnr.state.wi.us/org/land/forestry/usesof/bmp/bmptimberharvesting.htm#Planning>): This fact sheet, part of Wisconsin's *BMP Field Manual*, provides information on management practices related to timber harvesting.
- **University of Nebraska and Nebraska Forest Service, *Timber Harvesting*** (<http://www.ianr.unl.edu/pubs/forestry/nfs/nfs-1.htm#th>): This fact sheet is part of the online document, *Forestry Best Management Practices for Nebraska: A Reference Guide for Loggers, Landowners and Managers*. It provides documentation on management practices for timber harvesting.
- **Wisconsin Department of Natural Resources and University of Wisconsin, Madison, Department of Forestry, *Timber Harvesting*** (<http://forest.wisc.edu/extension/publications/7.pdf>): This fact sheet is part of Wisconsin's *Forestry Best Management Practices for Water Quality* series, *Forestry Facts*. It provides information on timber harvesting practices to protect water quality.
- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality (4<sup>th</sup> Edition)*** (<http://www.dof.virginia.gov/wq/index-bmp->



[guide.shtml](#)): This comprehensive manual contains clear, well-organized background information and fact sheets on timber harvesting, as well as related management practices.

#### 2.2.7.4 Case Studies

*NPS Impacts from Forestry Activities.* The amount of soil disturbance caused by yarding depends on the slope of the area, the volume yarded, the size of the logs, and the logging system. A study by Megahan (1980) ranked yarding techniques based on percent area disturbed per yarding technique. Aerial and skyline cable techniques were found to be far less damaging than other yarding techniques. Percent soil disturbance results were as follows: tractor (21 percent average), ground cable (21 percent, one study), high-lead (16 percent average), skyline (8 percent average), jammer in clear cut (5 percent, one study), and aerial techniques (4 percent average).

*Impacts of Forest Practices on Surface Erosion.* The amount of road needed to harvest timber also varies considerably with yarding technique. A study by Sidle (1980) examined the amount of road area needed for different timber yarding techniques. Skyline techniques were found to use the least amount of road area, with only 2 to 3.5 percent of the land area required for roads. Tractor and single-drum jammer techniques used the greatest amount of road area (10 to 15 percent and 18 to 24 percent of total area, respectively). High-lead cable techniques fell in the middle, with 6 to 10 percent of the land used for roads. Compared with the skyline and aerial techniques, the tractor, jammer, and high-lead cable methods resulted in significantly higher amounts of disturbed soil (Megahan, 1980).

#### 2.2.7.5 References

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- Megahan, W.F. 1980. Nonpoint source pollution from forestry activities in the western United States: Results of recent research and research needs. In *U.S. Forestry and Water Quality: What Course in the 80s?*, Proceedings of the Water Pollution Control Federation Seminar, Richmond, VA, June 19, 1980, pp. 92-151.
- Sidle, R.C. 1980. *Impacts of Forest Practices on Surface Erosion*. Pacific Northwest Extension Publication PNW-195, Oregon State University Extension Service.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

## 2.2.8 Management Measure 2F Site Preparation and Forest Regeneration

### *Management Measure*

Confine onsite potential NPS pollution and erosion resulting from site preparation and the regeneration of forest stands. The components of the management measure for site preparation and regeneration are as follows:

1. Select a method of site preparation and regeneration suitable for the site conditions.
2. Conduct mechanical tree planting and ground-disturbing site preparation activities on the contour of sloping terrain.
3. Do not conduct mechanical site preparation and mechanical tree planting on Streamside Management Areas (SMAs).
4. Protect surface waters from logging debris and slash material.
5. Suspend operations during wet periods.
6. Locate windrows at a safe distance from drainages and SMAs to control movement of the material during high runoff conditions.
7. Conduct bedding operations in high-water-table areas during dry periods of the year. Conduct bedding in sloping areas on the contour.
8. Protect small ephemeral drainages when conducting mechanical tree planting.

### 2.2.8.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrc-mgt.php>).

The Forestry Incentives Program (FIP) is a cooperative program involving the California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service. FIP's purpose is to enhance the productivity of private, nonindustrial forestland by providing financial and technical assistance for timber stand improvement and reforestation, such as site preparation and seedling planting (<http://www.fire.ca.gov/ResourceManagement/ForestryIncentiveProgram.asp>).

### 2.2.8.2 Management Practices

The goals of site preparation activities are to encourage maximum timber productivity, minimize fire hazards, prevent substantial adverse effects on soil resources and on fish and wildlife habitat, and prevent degradation of water quality. Site preparation has both short- and long-term components. Short-term goals can include treating logging slash to reduce the risk of wildfire and eliminate habitat for disease organisms. Long-term goals are aimed at creating conditions favorable to growing the next rotation of desired timber species. Site preparation and regeneration techniques influence the concentration of nutrients, pesticides, and sediment in runoff several years after timber harvest.

#### *Site Preparation Practices*

- *Timber harvest plan addendum:* Where site preparation will occur on the logging area, site preparation details should be included in an addendum to the timber harvest plan (THP). Relevant details include the general methods of site preparation to be used, the types of equipment, if any, to be used for mechanical site preparation and firebreak construction, the methods for protecting any desirable residual trees in accordance with CDF regulations, a map identifying the boundaries of site preparation areas, and a timetable of site preparation operations.
- *Streamside Management Areas:* Provide SMAs of sufficient width to protect streams from sedimentation by the 10-year storm and do not conduct mechanical site preparation in SMAs.
- *Runoff control and dispersal:* Use undisturbed areas to control and disperse concentrated runoff from roads, landings, tractor roads, firebreaks, and erosion control facilities where it flows into site preparation areas.
- *Slash management:* Logging slash that poses a fire hazard to homes, roads, or recreation areas should be lopped, removed, chipped, or piled and burned according to CDF regulations. Broadcast burning should be conducted so that it does not fully consume the larger organic debris that retains soil on slopes and stabilizes watercourse banks. Slash should not be placed in perennial or intermittent drainages, and any slash that accidentally enters drainages should be removed. Slash can clog the channel and cause alterations in drainage configuration and increases in sedimentation, and extra organic material can lower the dissolved oxygen content of the stream. Slash also allows silt to accumulate in the drainage and to be carried into the stream during storm events.
- *Windrows:* These should be located a safe distance from drainages to prevent material from moving into the drainages during high-flow conditions. Locating windrows above the 50-year floodplain usually prevents windrowed material from entering floodwaters.
- *Pest control:* Timber operations should be conducted in such a way as to minimize the buildup of destructive insect populations and the spread of forest diseases. Site preparation measures should be carried out to mitigate adverse infestation or infection impacts from the timber operation. Insects breeding in pine logging slash can be a significant problem. Measures to reduce insect diseases include removing logging slash from the site, piling and burning, chipping, debarking, treating with an appropriate pesticide, or piling and covering the slash with clear plastic.
- *Erosion control:* Soil movement should be minimized when shearing, piling, or raking. Incorporation of soil material into windrows and piles during their construction should be avoided. A rake, rather than a blade, should be used to move slash. If using a blade is unavoidable, the blade should be kept above the soil surface. This helps retain nutrient-rich

topsoil, which promotes rapid site recovery and tree growth and increases the effectiveness of the windrow in minimizing sedimentation.

- **Heavy equipment:** Heavy equipment for site preparation should not be used under saturated soil conditions. Mechanical site preparation (except drum chopping) should not be conducted on slopes greater than 30 percent. On sloping terrain greater than 10 percent, or on highly erosive soils, mechanical site preparation equipment should be operated on the contour.

#### *Forest Regeneration Practices*

USEPA (1993) recommends that seedlings be distributed evenly across the site and be ordered well in advance of planting time to ensure their availability. On highly erodible sites and steep slopes, and within SMAs, it is recommended that seedlings be planted by hand rather than using heavy equipment. Heavy equipment used in other areas should be operated along the contour of the slope to avoid forming ditches that can concentrate runoff and exacerbate erosion. Machines should not be operated on soils with steep slopes or excess moisture because they can become unstable and result in erosion or mass wasting, which could lead to injuries or pollution. Slits dug for planting seedlings should be closed at numerous points along their length to reduce the likelihood of channeling flows.

### 2.2.8.3 Information Resources

- **California Forest Stewardship Program, *Developing Your Forest Stewardship Plan*** (<http://ceres.ca.gov/foreststeward/html/stewardplan.html>): This fact sheet provides information on the benefits of a forest stewardship plan.
- **Wisconsin Department of Natural Resources and University of Wisconsin, Madison, Department of Forestry, *Site Preparation and Tree Planting*** (<http://forest.wisc.edu/extension/publications/8.pdf>): This fact sheet is part of *Wisconsin's Forestry Best Management Practices for Water Quality* series, *Forestry Facts*. It provides information on site preparation and tree planting to protect water quality.
- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality, Fourth Edition*** (<http://www.dof.virginia.gov/wq/index-bmp-guide.shtml>): This comprehensive manual contains clear, well-organized background information and fact sheets on site preparation, as well as related practices.

### 2.2.8.4 Case Studies

*Impact of Forest Management on Northern Forest Soils.* Ballard (2000) reviewed the effects of forest management on forest soils. Mechanical site preparation, he noted, has benefits and causes problems. Nutrient depletion is one adverse effect. A study in northern British Columbia concluded that 500 kilograms of nitrogen per hectare were removed on a large area that had been bladed, raked, and piled for burning. However, Piatek and Allen (2000) found that the nutrients removed during site preparation had no observable effect on foliage production when measured 15 years after planting on the site.

*Economic Impacts of Erosion Control in Forests.* Dissmeyer (1986) analyzed the economic benefits of controlling erosion during site preparation. Site preparation methods that increased soil exposure, displacement, and compaction increased site preparation costs and erosion from the site prepared and decreased timber production. Light site preparation techniques such as a single chop and burn reduced erosion, increased timber production on the site, and cost less per unit area treated than more intensive site preparation methods. Heavy site preparation techniques such as shearing and windrowing removed

nutrients, compacted soil, increased erosion and site preparation costs, and resulted in a lower present net value of timber.

#### 2.2.8.5 References

- Ballard, T.M. 2000. Impacts of forest management on northern forest soils. *Forest Ecology and Management* 133: 37-42.
- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- Dissmeyer, G.E. 1986. Economic impacts of erosion control in forests. In *Proceedings of the Southern Forestry Symposium*, November 19-21, 1985, Atlanta, GA, edited by S. Carpenter, Oklahoma State University Agricultural Conference Series, pp. 262-287.
- Piatek, K.B., and H.L. Allen. 2000. Site preparation effects on foliar N and P use, retranslocation, and transfer to litter in 15-year old *Pinus taeda*. *Forest Ecology and Management* 129: 143-152.
- USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (<http://www.epa.gov/owow/nps/MMGI/index.html>)

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

## 2.2.9 Management Measure 2G Fire Management

### *Management Measure*

Prescribe fire for site preparation and control or suppress wildfire in a manner that reduces potential NPS pollution of surface waters.

1. Intense prescribed fire should not cause excessive erosion due to the combined effect of removal of canopy species and the loss of soil-binding ability of subcanopy and herbaceous vegetation roots, especially in Streamside Management Areas (SMAs), in streamside vegetation for small ephemeral drainages, or on very steep slopes.
2. Prescriptions for prescribed fire should protect against excessive erosion or prevent sedimentation.
3. All bladed fire lines, for prescribed fire and wildfire, should be plowed on contour or stabilized with water bars and/or other appropriate techniques if needed to control excessive sedimentation or erosion of the fire line.
4. Rehabilitation and salvage logging areas burned by wildfires should be managed to minimize erosion and prevent sedimentation.

### 2.2.9.1 Programs

The Vegetation Management Program (VMP) administered by the California Department of Forestry (CDF) is a cost-sharing program that focuses on the use of prescribed fire, and mechanical means, for addressing wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands (<http://www.fire.ca.gov/ResourceManagement/VegetationManagement.asp>).

The California Fire Plan is the State's road map for reducing the risk of wildfire. By placing the emphasis on what needs to be done long before a fire starts, the Fire Plan looks to reduce fire fighting costs and property losses, increase firefighter safety, and contribute to ecosystem health. The California Fire Plan is a cooperative effort between the State Board of Forestry and Fire Protection and the CDF (<http://www.fire.ca.gov/FireEmergencyResponse/FirePlan/FirePlan.asp>).

The CDF's Fire Emergency and Response team responds to wildfires within the State ([http://www.fire.ca.gov/php/fire\\_er.php](http://www.fire.ca.gov/php/fire_er.php)).

The CDF's Fire and Resource Assessment Program assesses the amount and extent of California's forests and rangelands, analyzes their conditions, and identifies alternative management and policy guidelines (<http://frap.cdf.ca.gov/index.htm>).

### 2.2.9.2 Management Practices

Fire management practices are changing as the benefits of fire to forest ecosystems are becoming more widely accepted. Prescribed burning reduces hazardous fuels and reduces the potential for crown fires that kill timber trees. Fire is also essential for forest management where tree species are ecologically dependent on fire for regeneration or maintenance of healthy stands (USEPA, 2002). However, prescribed fire used for site preparation, fuel hazard reduction, and activities associated with wildfire suppression can sometimes create NPS pollution and erosion. The following management measures can be used to reduce the adverse impacts of fire on water quality:

- *Fire intensity:* High-intensity fires should be avoided, especially severe burns on steep slopes or highly erodible soils. High-intensity fires that remove vegetation and litter down to the mineral soil are most likely to adversely affect water quality. Furthermore, chemical changes in the soil following fire may create an increased resistance to water infiltration in the upper soil layer, and this can increase surface runoff and sheet erosion (USEPA, 2002). Periodic, low-intensity prescribed fires should be used to reduce the forest fuel loads. Low-intensity fires usually have little effect on water quality because burned areas with an intact litter layer yield little sediment and revegetate more quickly.
- *Timing of prescribed burns:* Burning should be planned to take into account weather, time of year, and fuel conditions so that these factors help achieve the desired results and minimize effects on water quality.
- *Logistics of prescribed burns:* The prescribed burn should be executed with an agency-qualified crew and burn boss. Burning permits must be obtained before burning. Every year, if required, either before April 1 or before the start of timber operations, a fire suppression resources inventory should be submitted to the CDF.
- *SMAs and wetlands:* Prescribed burning and site preparation activities that involve piling and burning for slash removal should not be conducted in SMAs. When applying prescribed fire in wetlands, burns should be conducted in a manner that does not completely remove the organic layer of the forest floor. Prescribed burns conducted in wetlands have the potential to be the most severe because of the increased fuels available. The fire should be conducted to minimize the potential to increase surface runoff and soil erosion. Fire lines should not be placed in sensitive areas such as wetlands, marshes, prairies, and savannas unless absolutely necessary.
- *Fire lines:* Fire line construction involves removing all organic material to expose mineral soil, and this can result in excessive erosion and water quality degradation. Natural or in-place barriers (e.g., roads, streams, and lakes) should be used to minimize the need for fire line construction in situations where construction of artificial fire lines could result in excessive erosion and sedimentation. Conditions that require extensive blading of fire lines with heavy equipment should be avoided when planning burns. Hand lines, firebreaks, and hose lays should be used to minimize blading of fire lines.

Fire lines need to be constructed in a manner that minimizes erosion and sedimentation and prevents runoff from directly entering watercourses. When crossing water bodies with plowing equipment, the plow should be raised to prevent connecting the fire line directly to the water body. Water bodies can be used as fire lines to avoid unnecessarily disturbing riparian zones. Also, construction of fire lines straight up and down hill should be avoided. The location of fire lines should be balanced with the potential for a larger fire that would consume greater amounts



of material. Where possible, alternatives to plowed lines such as harrowing, foam lines, wet lines, or permanent grass should be considered.

- *Revegetation:* Once the fire is put out, vegetative cover on fire lines and disturbed areas should be reestablished as soon as possible using native species, as feasible, to control soil erosion.
- *Runoff controls:* Grades, ditches, and water bars to fire lines should be installed as soon as it is safe to begin rehabilitation work. Water bars should be installed on any fire line running up and down the slope, and runoff should be directed onto a filter strip or sideslope, not into a drainage area.
- *Fire retardants:* Whenever possible, a 300-foot buffer should be left on both sides of a waterway when fire retardants are applied from the air. If it is necessary to apply retardant within the 300-foot zone, the application method that most accurately keeps the retardant from entering the stream should be used. Fire retardant chemicals that contain sodium ferrocyanide should be avoided because a recent study revealed that mixtures with the chemical can decompose to produce amounts of cyanide that exceed USEPA water quality guidelines for freshwater organisms.
- *Fire detection/prevention:* A diligent aerial or ground inspection should be conducted within the first 2 hours after cessation of felling, yarding, or loading operations each day during the dry period when fire is likely to spread. The person conducting the inspection should have adequate communication available for prompt reporting of any fire that may be detected (CDF, 2003).

Laws and ordinances prohibiting or otherwise regulating smoking should be obeyed and smoking by persons engaged in timber operations should be limited to occasions when they are not moving about and are confined to cleared landings and areas of bare soil at least 3 feet in diameter.

- *Public safety:* Management practices for fire lines, road construction, and stream crossings should be suspended during wildfire emergencies to benefit public safety and should be restored as soon as possible. Remediation should begin after the emergency is controlled.

Costs associated with prescribed fire depend on the size of the fire crew, the amount of heavy equipment needed at the site to control the burn, the areal extent and intensity of the burn, and the topography of the area being burned. Costs for prescribed burning vary from approximately \$80 to \$500 per acre; costs are higher in mountainous terrain than on flat land (USEPA, 2002).

### 2.2.9.3 Information Resources

- *The Defensible Space and Healthy Forest Handbook: A Guide to Reducing the Wildfire Threat* (<http://ceres.ca.gov/foreststeward/html/firesafehandbook.html>): This handbook is an excellent resource, prepared by the Placer Hills Fire Protection District, Placer County RCD and the USDA NRCS for residents of the Sierra Nevada foothills. The booklet is available for \$15.
- *Protect Your Forest from Wildfire* (<http://ceres.ca.gov/foreststeward/html/protectforest.html>): This Web site provides information on protecting private land from wildfires.
- *California Fire and Resource Assessment Program, Fire Management for California Ecosystems* ([http://frap.cdf.ca.gov/projects/fire\\_mgmt/fm\\_main.html](http://frap.cdf.ca.gov/projects/fire_mgmt/fm_main.html)): This paper discusses the use of an ecosystem management focus for fire management.

- **California Fire and Resource Assessment Program, *Prefire Management*** ([http://frap.cdf.ca.gov/projects/prefire\\_mgmt/pfm\\_main.html](http://frap.cdf.ca.gov/projects/prefire_mgmt/pfm_main.html)): This Web site provides information on prefire management of California's forests.
- **California Fire and Resource Assessment Program, *Turning Plantations into Healthy, Fire Resistant Forests, Outlook for the Granite Burn*** ([http://frap.cdf.ca.gov/projects/granite\\_burn/gb\\_exec.html](http://frap.cdf.ca.gov/projects/granite_burn/gb_exec.html)): This paper explores individual stand conditions of Granite Burn and current fuel and forest structure problems. It offers general recommendations for reducing risks to these stands in the future.
- **California Department of Forestry and Fire Protection, *The Benefits of Fire*** (<http://www.fire.ca.gov/FireEmergencyResponse/pdf/TheBenefitsofFire.pdf>): The fact sheet discusses the benefits of fires to forests.
- ***Fire Protection and Resource Management: A Necessary Alliance*** (<http://ceres.ca.gov/foreststeward/html/necessary.html>): This fact sheet discusses the importance of controlled forest fires in forest resource management.
- **California Fire Alliance** (<http://www.cafirealliance.org/>): This is an association of cooperating agencies addressing fire issues in California.

#### 2.2.9.4 Case Studies

*Cone Fire in Lassen National Forest.* The Cone Fire that occurred September 2002 on the Lassen National Forest (NF) provided wildland fire experts and forestry researchers a way to study the effects of fuel treatments on an active wildfire. Areas in the Lassen NF had been managed with different forest fuel treatments over the years, including prescribed fire and tree thinning. Initial observations indicate that high intensity burns occurred in areas that had received no management with thinning or prescribed fire. The timber stands that had been treated with thinning, prescribed fire, or both, experienced a low-intensity ground fire, resulting in lower tree mortality. Some treatments were observed to be very effective in slowing, and sometimes even stopping, the fire ([http://www.cafirealliance.org/success\\_conefire.php](http://www.cafirealliance.org/success_conefire.php)).

*Gasquet Community Fire Protection Successes.* The community of Gasquet in the Smith River National Recreation Area, Six Rivers National Forest, had been identified as a community at risk from wildfire. In the spring of 1996, fuel reduction activities were implemented in forest lands surrounding the community in an area called the Gasquet Shaded Fuelbreak. Prescribed fire reduced the density of smaller branches, twigs, and needles, which are known to foster the spread of fire. In September 1996, the Panther Fire threatened Gasquet. When the Panther Fire burned into the Gasquet Shaded Fuelbreak, the fire lost intensity, allowing fire crews to contain the advancing head of the fire. No structures in Gasquet were lost or damaged ([http://www.cafirealliance.org/success\\_nfp.php](http://www.cafirealliance.org/success_nfp.php)).

#### 2.2.9.5 References

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## 2.2.10 Management Measure 2H Revegetation of Disturbed Areas

### *Management Measure*

Reduce erosion and prevent sedimentation by rapid revegetation of areas disturbed by timber operations.

1. Revegetate disturbed areas (using seeding or planting) promptly after completion of earth-disturbing activity. Local growing conditions will dictate the timing for establishment of vegetative cover.
2. Use mixes of species and treatments developed and tailored for successful vegetation establishment for the region or area.
3. Concentrate revegetation efforts initially on priority areas such as disturbed areas in Streamside Management Areas (SMAs) or the steepest areas of disturbance near drainages.

### 2.2.10.1 Programs

California Department of Forestry and Fire Protection, State Nurseries. The Lewis A. Moran Reforestation Center in Yolo County and the Magalia Reforestation Center In Butte County make up the CDF Nursery System. The purpose of the reforestation centers is to provide native species seedlings for purchase by landowners for specific purposes, including reforestation, erosion control and watershed protection, windbreaks, Christmas trees, fuel wood, and approved research projects (<http://www.fire.ca.gov/ResourceManagement/StateNurseries.asp>).

### 2.2.10.2 Management Practices

A recently harvested or burned site is highly susceptible to erosion and should be protected immediately with a combination of new vegetation and more temporary controls to hold soil in place while the plantings take hold. The following are the major considerations for site revegetation:

- *Plant selection:* For revegetation efforts, native species should be selected as much as possible. Mixtures of seeds adapted to the site and annuals should be used to allow natural revegetation of native understory plants. Mixtures should include annual grasses (for quick growth), perennial grasses (for their better root systems), and legumes (for nitrogen). Especially preferable are species that have adequate soil-binding properties to control erosion. Seeds should be planted immediately after soil disturbance and a minimum of 6 weeks before periods of drought or frost. Fall seeding is best. Native woody plants planted in rows, cordons, or wattles are best on steep slopes.
- *Timing and methodology:* Seeding should be done as soon as is practical after soil disturbance, preferably before rain, to increase the chance of successful establishment. Seeding can be done by hand or vehicle or by hydraulic seeding from a pump truck or trailer. The seed should be evenly distributed to provide continuous cover. Soil should be mulched as needed to hold seeds in place, reduce the erosive impact of raindrops, and to preserve soil moisture. Fertilizer should be applied according to product labels and site-specific conditions. Fertilizers may be necessary in severely

disturbed subsoils and cutbanks. Soils should be tested for nutrient content to ensure that the proper amount of fertilizer is applied.

- **Maintenance:** Once areas are seeded, they should be protected from grazing and vehicle damage until plants are well established. All seeded areas should be inspected for failures and repairs, and reseeding should be accomplished within the planting season. During non-growing seasons, temporary, interim surface stabilization methods should be used to control surface erosion. These can include mulching, spraying bare soils with tackifiers, or covering exposed areas with turf reinforcement mats.

### 2.2.10.3 Information Resources

- **Shasta County University of California Cooperative Extension, *Recovering from Wildfire:*** This publication covers emergency resources, how to assess damages, erosion control measures, road protection, salvage harvesting, and forest regeneration. There are tips on contracting with a registered professional forester and a short discussion of tax implications. There is also a section on cost-share programs and a list of contacts. Request a copy from Shasta County University of California Cooperative Extension, Forestry, 1851 Hartnell Avenue, Redding, CA 96002 (Telephone: 530-224-4902) or call the California Stewardship Helpline (Telephone: 1-800-PET-TREE).
- ***Evaluating the Effectiveness of Postfire Rehabilitation Treatments*** ([http://www.fs.fed.us/rm/pubs/rmrs\\_gtr63.html](http://www.fs.fed.us/rm/pubs/rmrs_gtr63.html)): A west-wide evaluation of the effectiveness of USDA Forest Service burned area emergency rehabilitation (BAER) treatment was undertaken as a joint project by USDA Forest Service Research and National Forest System staffs. This evaluation covers 470 fires and 321 BAER projects, from 1973 through 1998 in USDA Forest Service Regions 1 through 6. A literature review, interviews with key regional and USDA Forest Service BAER specialists, analysis of burned area reports, and review of USDA Forest Service and district monitoring reports were used in the evaluation.
- **California Exotic Pest Plant Council** (<http://www.caleppc.org>): This council works to protect California wildlands from invasive plants through research, restoration, and education.
- **Alabama Forestry Commission, *Revegetation/Stabilization*** ([http://www.forestry.state.al.us/publication/bmp/Revegetations\\_Stabilization.pdf](http://www.forestry.state.al.us/publication/bmp/Revegetations_Stabilization.pdf)): This fact sheet, part of *Alabama's Best Management Practices for Forestry*, provides guidance on techniques for revegetating disturbed areas.
- **USEPA, *Watershed Academy Web: Forestry Best Management. Revegetation and Forest Regeneration*** (<http://www.epa.gov/watertrain/forestry/subf1.htm>): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.

### 2.2.10.4 Case Study

*Restoring the land after the Pendola Fire.* After 2 days of the Pendola Fire in October 1999, dozens of landowners were burned out and over 11,000 acres of forestland destroyed. The community immediately turned to restoration, and within a few weeks, applications for CFIP (California Forest Improvement Program) cost-share funds began to come in. "We've been impressed with the aggressive manner in which people are reforesting their land," noted Gary Brittner, who manages CFIP for the CDF for the Nevada-Yuba-Placer Unit. "This is high-quality land and reforestation after a fire is an important priority." The effort to start the restoration work has involved landowners, registered professional

foresters (RPFs), and government agencies such as CDF. In addition to CFIP, other emergency funds such as CFIP (California Forestry Improvement Program) are available to landowners who have been affected by fire (<http://ceres.ca.gov/foreststeward/html/pendola.html>).

#### **2.2.10.5 References**

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Weaver, W., and D. Hagans. 1994. *Handbook for Forest and Ranch Roads: A Guide For Planning, Designing, Constructing, Reconstructing, Maintaining and Closing Wildland Roads*. Mendocino County Resource Conservation District, Ukiah, CA.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## **2.2.11 Management Measure 2I Forest Chemical Management**

### *Management Measure*

Use chemicals when necessary for forest management in accordance with the following to reduce NPS pollution impacts due to the movement of forest chemicals offsite during and after application:

1. Ensure that applications are performed by skilled and licensed applicators according to the registered use, with special consideration given to impacts on nearby surface waters.
2. Carefully prescribe the type and amount of pesticides appropriate for the insect, fungus, or herbaceous species.
3. Prior to applications of pesticides and fertilizers, inspect the mixing and loading process and the calibration of equipment, and identify the appropriate weather conditions, the spray area, and buffer areas for surface waters and mixing and loading areas.
4. Establish and identify buffer areas for surface waters to protect beneficial uses. (This is especially important for aerial applications.)
5. Immediately report accidental spills of pesticides or fertilizers into surface waters to the California Office of Emergency Services (Cal/OES). Develop an effective spill contingency plan to contain spills.

### **2.2.11.1 Programs**

California Department of Forestry and Fire Protection Pest Management Program. Forest pest specialists help protect the State's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands (<http://www.fire.ca.gov/ResourceManagement/ForestPest.asp>).

California Department of Pesticide Regulation has programs to protect human health and the environment by regulating the sale and use of pesticides, and by fostering reduced-risk pest management in California (<http://www.cdpr.ca.gov/>).

### **2.2.11.2 Management Practices**

Pesticides and fertilizers are occasionally used in forestry to reduce mortality of desired tree species and improve forest production. Because pesticides can be toxic if misused, they must be mixed, transported, loaded, and applied correctly (according to label instructions) to prevent potential NPS pollution. Fertilizers can also be toxic or can shift the ecosystem's energy dynamics when used improperly, so it is important that they also be handled and applied in accordance with instructions on the label (USEPA, 2002).

*Methods of chemical application:* Generally, chemicals are applied by hand, from an airplane or helicopter (aerial spray), or mechanically. When forest chemicals are applied mechanically, it is most common to use a vehicle-mounted boom sprayer. The cost of chemical management depends on the method of application. Hand application costs approximately \$100 per acre, while aerial application is less expensive at \$55 to \$70 per acre.

Using slow-release fertilizers when possible can reduce adverse impacts on the environment. This practice reduces potential nutrient leaching to ground water and it increases the availability of nutrients for plant uptake. Fertilizers should be applied during maximum plant uptake periods to minimize leaching. Fertilizers and herbicides should not be used in streams or Streamside Management Areas. If designed properly, forested buffer areas around watercourses can effectively reduce adverse effects on water quality from fertilizers (Megahan, 1980).

Riekerk and others (1989) found that the greatest risk to water quality from pesticide application in forestry operations occurred from aerial application because of drift, wash-off, and erosion processes. They found that aerial applications of herbicides resulted in surface runoff concentrations roughly 3.5 times greater than those for application on the ground. Therefore, where possible, aerial application of pesticides should be avoided. Alternatively, tree injection or hand application of herbicides should be used. Research results suggest that tree injection application methods, although labor intensive, are the least hazardous for water pollution (Riekerk et al., 1989).

When aerial spray applications are used, drift or accidental application of chemicals directly to surface waters should be avoided. Appropriate buffer widths should be determined by considering the altitude of application, weather conditions, and drop size distribution. Careful and precise marking of application areas for aerial applications helps avoid accidental contamination of open waters (USEPA, 2002).

Pesticides and fertilizers should be applied only during favorable atmospheric conditions. Pesticides should not be applied when wind conditions increase the likelihood of significant drift. It is also best to avoid pesticide application when temperatures are high or relative humidity is low because these conditions influence the rate of evaporation and enhance losses of volatile pesticides.

*Following the label:* Pesticide users need to abide by the current pesticide label, which could specify the following: whether users be trained and certified in the proper use of the pesticide; allowable use rates; safe handling, storage, and disposal requirements; and whether the pesticide may be used only under the provisions of an approved State Pesticide Management Plan.

*Spill prevention:* Areas where mixing, loading, and equipment cleaning occur should be located where pesticide residues cannot enter streams or other water bodies. Pesticide wastes and containers should be disposed of according to State and federal laws and precautions should be taken to prevent leaks and spills.

*Integrated Pest Management:* Ideally, the use of pesticides should be considered as only one part of an overall program to control pest problems. Integrated Pest Management (IPM) strategies have been developed to control forest pests without total reliance on chemical pesticides. The IPM approach uses all available techniques, including both chemical and nonchemical methods. An extensive knowledge of both the pest and the ecology of the affected environment is necessary for IPM to be effective.



### 2.2.11.3 Information Resources

- **Tree Notes** (<http://ceres.ca.gov/foreststeward/html/treenotes.html>): Tree Notes is a series of short papers produced by the California Department of Forestry and Fire Protection to provide information on various pests and threats to forests. These resources are available from the local forester at any CDF Unit or call or write Jesse Rios, Forest Pest Specialist, P.O. Box 944246, Sacramento, CA 94244 (Telephone: 916-653-9476).
- **Pest Management In Perspective** (<http://ceres.ca.gov/foreststeward/html/pest.html>): This is an article about pest management in forests.
- Norris et al., 1991. *Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats*. American Fisheries Society Special Publication 19, pp. 207-296. This publication can be ordered online at: <http://64.224.98.53/publications/catbooks/x51015.shtml>
- **USDA Forest Service, Pacific Southwest Region, Forest Health Protection (FHP), Forest Pests** ([http://www.fs.fed.us/r5/spf/about/fhp\\_forest\\_pests.htm](http://www.fs.fed.us/r5/spf/about/fhp_forest_pests.htm)): FHP is responsible for protecting, monitoring, and reporting on the health of all forest lands in the Pacific Southwest Region. FHP provides assistance in pest and pathogen identification.
- **University of California Statewide Integrated Pest Management Program (UC IPM)** (<http://www.ipm.ucdavis.edu/>): UC IPM develops and promotes the use of integrated, ecologically sound pest management programs in California. UC IPM's mission is to reduce the pesticide load in the environment and develop pest control programs that are economically, environmentally, and socially acceptable.
- **Spray Drift Task Force** (<http://www.agdrift.com/>): The Spray Drift Task Force, in collaboration with USEPA and USDA, co-developed AgDRIFT, a new model, to provide estimates of spray drift deposition under different pesticide application and meteorological conditions.
- **USDA Forest Service Cramer-Barry-Grim (FSCBG)** (<http://www.fs.fed.us/foresthealth/technology>): The FSCBG spray dispersion model analyzes data on aircraft, meteorology, pesticides, and target areas to predict deposition and drift. A personal computer version of the model is available. It combines and implements mathematical models to assist forest managers in planning and implementing aerial spray operations.
- **USEPA, Watershed Academy Web: Forestry Best Management, Forest Chemicals.** (<http://www.epa.gov/watertrain/forestry/subh1.htm>): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **University of California Statewide Integrated Pest Management Program, Forest and Right-of-Way Pest Control** ([http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual\\_forestrightofway.html](http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_forestrightofway.html)): This book is a guide to pest management in forests, as well as rights-of-way and commercial nurseries. It is geared specifically toward pesticide professionals in California.

### 2.2.11.4 Case Study

*Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats.* A nitrogen loss study cited in Norris and others (1991), compared nitrogen loss from a watershed treated with 224 kilograms (kg) urea-nitrogen per hectare with nitrogen loss from an untreated watershed. The study demonstrated that the loss of nitrogen from the fertilized watershed was 28.02 kg/hectare whereas the loss of nitrogen from the unfertilized watershed was only 2.15 kg/hectare.

Norris and others (1991) also compiled information from multiple studies that evaluated the peak concentrations of insecticides in soils, lakes, and streams. It was demonstrated that the concentration of insecticides in streams was significantly greater when the chemicals were applied without a buffer strip to protect the watercourse. In one study, when streams were unbuffered, the peak concentrations of applied malathion ranged from 0.037 to 0.042 milligrams per liter (mg/L). When buffers were provided, however, concentrations of malathion were reduced to levels that ranged from undetectable to 0.017 mg/L. In another experiment, the peak concentrations of carbaryl ranged from 0.000 to 0.0008 mg/L when watercourses were protected with a buffer, but they increased to 0.016 mg/L when watercourses were unbuffered.

#### 2.2.11.5 References

- Megahan, W.F. 1980. Nonpoint source pollution from forestry activities in the western United States: Results of recent research and research needs. In *U.S. Forestry and Water Quality: What Course in the 80s?* Proceedings of the Water Pollution Control Federation Seminar, Richmond, VA, June 19, 1980, pp. 92-151.
- Norris, L.A., H.W. Lorz, and S.V. Gregory. 1991. *Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats*. American Fisheries Society Special Publication 19, pp. 207-296.
- Riekerk, H., D.G. Neary, and W.J. Swank. 1989. The magnitude of upland silviculture nonpoint source pollution in the South. In *Proceedings of the Symposium: Forested Wetlands of the Southern United States*, July 12-14, Orlando, FL, pp. 8-18.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- Case Studies
- [References](#)

## 2.2.12 Management Measure 2J Wetlands Forest Management

### *Management Measure*

Plan, operate, and manage normal, ongoing forestry activities (including harvesting, road design and construction, site preparation and regeneration, and chemical management) to adequately protect the aquatic functions of forested wetlands.

### 2.2.12.1 Programs

The California Wetlands Information System is a program of the California Resources Agency. This Wetlands Information System is designed to provide comprehensive wetlands information to the general public, the educational community, and government agencies. It is a compilation of public and private sector information, including maps, environmental documents, agency roles in wetlands management, restoration and mitigation activities, regulatory permitting, and wetland policies. It also includes a wetlands database and inventory (<http://ceres.ca.gov/wetlands/>).

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrc-mgt.php>).

### 2.2.12.2 Management Practices

Forested wetlands provide beneficial ecosystem functions such as flood-flow alteration, sediment trapping, nutrient retention and removal, provision of important habitat for fish and wildlife, and provision of timber products. Wetlands in the continental United States have declined greatly in the past 40 years because of conversion to other land uses. In the past 200 years, California lost 91 percent of its original wetlands, mostly because of conversion to agriculture (Yuhas, 2003).

Practices that help maintain forested wetlands include the following:

- *Road building/maintenance:* Road construction and maintenance can adversely affect forested wetlands and should be avoided. Wetlands can fill with sediment runoff generated by road construction and the use of heavy equipment. Wetlands can also be degraded by improper road construction and ditching that alters wetland hydrology. In an effort to prevent these potential adverse effects, section 404 of the Clean Water Act (for more information about section 404, see <http://www.epa.gov/owow/wetlands/regs/sec404.html>) requires the use of appropriate management practices for road construction and maintenance in wetlands so that flow and circulation patterns are not impaired.

Temporary roads should be used in forested wetlands whenever possible. Temporary roads can be constructed to provide adequate crossroad drainage at all natural drainageways. Temporary drainage structures include culverts, bridges, and porous material such as corduroy or chunkwood. The root mat in any wetland that has grass mounds or other uneven vegetation should not be disturbed. Any temporary wetland crossing is enhanced by using a root or slash mat to provide additional support to the equipment.

Where construction of fill roads is necessary, a permeable fill material such as gravel or crushed rock should be used for at least the first layer of fill. The use of pervious materials helps maintain the natural flow regimes of subsurface water. Adequate cross drainage should be provided to maintain the natural surface and subsurface flow of the wetland.

- *Chemical use:* Wetland contamination can result from improper application or use of herbicides and fertilizers. Application of herbicides with toxicity to aquatic life should be avoided. Instead, herbicide formulations that are approved for use in or near water should be used where feasible and applicable. These herbicides should be applied by injection to individual stems to reduce losses to surface waters. Fertilizers should be applied when leaching will be minimal, and slow-release fertilizers should be chosen when possible. This practice reduces the potential of the nutrients to leach in to ground water, and it increases the availability of nutrients for plant uptake.
- *Site preparation:* Site preparation techniques that degrade wetlands onsite or downstream should be avoided. Extensive site preparation on bottoms where frequent flooding occurs can cause excessive erosion and stream sedimentation. The degree of acceptable site preparation is governed by the amount and frequency of flooding, soil type, and species suitability and depends on the regeneration method used.
- *Permits:* Local, State, and federal agencies should be conferred with to identify applicable wetland regulations and obtain necessary permits to work in wetlands. Some forestry activities in wetlands are exempt from federal permitting requirements under section 404(f) of the Clean Water Act, while others are not.
- *Harvesting:* Harvest methods that cause less soil disturbance and compaction, such as cable logging or helicopter logging, should be considered. If using heavy equipment, low-ground-pressure, ultrawide, or high-flotation tires on logging trucks and skidders should be used to reduce soil compaction and erosion. Ground skidding harvesting operations should be suspended during wet periods in seasonally flooded wetlands.

### 2.2.12.3 Information Resources

- **Save The Bay, *Protecting Local Wetlands: a Toolbox for Your Community*.** (<http://www.savesfbay.org/atf/cf/{2D306CC1-EF35-48CC-B523-32B03A970AE5}/ProtectingWetlands.pdf>): This document, produced by Save The Bay, in conjunction with the attorneys of Shute, Mihaly, and Weinberger, LLP, is designed to help government officials, resource agencies, nonprofit organizations, community activists, and landowners protect and restore their local wetlands throughout the San Francisco Bay-Delta Estuary.
- **USDA Forest Service, USDA NRCS, and USEPA, *Forested Wetlands Functions, Benefits, and Use of Best Management Practices*** ([http://www.na.fs.fed.us/spfo/pubs/n\\_resource/wetlands/index.htm#Table%20of%20Contents](http://www.na.fs.fed.us/spfo/pubs/n_resource/wetlands/index.htm#Table%20of%20Contents)): The purpose of this publication is to present an array of management practices to protect the function of forested wetlands.

- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality, 4<sup>th</sup> Edition*** (<http://www.dof.virginia.gov/wq/index-bmp-guide.shtml>): This comprehensive manual contains clear, well-organized background information and fact sheets on forested wetlands, as well as related practices.
- **Alabama Forestry Commission, *Forested Wetland Management*** ([http://www.forestry.state.al.us/publication/bmp/Forest\\_Wetland\\_Management.pdf](http://www.forestry.state.al.us/publication/bmp/Forest_Wetland_Management.pdf)): This fact sheet, part of *Alabama's Best Management Practices for Forestry*, provides background information on the management of forested wetlands.
- **USEPA, *Watershed Academy Web: Forestry Best Management. Forest Wetland Management*** (<http://www.epa.gov/watertrain/forestry/subc1.htm>): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **USEPA, *Forested Swamps*** (<http://www.epa.gov/owow/wetlands/types/swamp.html#forested>): This Web site provides information on various types of forested wetlands.

#### 2.2.12.4 References

- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- Yuhas, R.H. 2003. *Loss of Wetlands in the Southwestern United States*. U.S. Geological Survey. (<http://geochange.er.usgs.gov/sw/impacts/hydrology/wetlands/>). Accessed March 27, 2003.

**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

## 2.2.13 Management Measure 2K Postharvest Evaluation

### *Management Measure*

Conduct post-operation evaluation of the effectiveness of the State's forest practices requirements as implemented. The components of this are (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.

### 2.2.13.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (<http://www.fire.ca.gov/php/rsrc-mgt.php>).

### 2.2.13.2 Management Practices

*Timber harvest plan:* Post-harvest evaluations of forest practices should be incorporated into the timber harvest plan (THP) if proposed timber operations have the potential to degrade drinking water supplies, lakes, or streams. Under the California Forest Practice Rules, the CDF may require a postharvest evaluation of the effectiveness of the mitigations and practices designed to protect the domestic water supply as a condition of THP approval. Problems to be identified include potential land failures, accelerated rate of road construction or harvesting within a watershed, or a concentration or intensity of harvesting activity near streams or springs (CDF, 2003). Where timber operations will be conducted within a Watercourse and Lake Protection Zone (WLPZ), the CDF may also require a postharvest evaluation of the effectiveness of the mitigation measures and practices designed to protect the water quality as a condition of THP approval.

*Monitoring program:* One should define the goals and objectives, or purpose, of the monitoring program. Detailed monitoring program objectives enable the designer of the program to define precisely which data will be gathered to meet the management goals and determine when management has failed or been successful. Postharvest evaluations can review the timber operator's procedures for effectiveness and implementation monitoring or existing landowner monitoring programs, or use photographic monitoring techniques. A review of scientific and technical literature pertaining to water quality studies previously conducted in the region will help to determine whether existing data provide sufficient information to address the monitoring goals and to identify data gaps.

*Implementation assessments:* It is helpful to identify project constraints such as funding, staffing, equipment, time, and effort necessary to complete postharvest evaluations. The duration of monitoring and the geographic scale needed to achieve monitoring goals should be determined. Implementation

assessments can be done on several scales. Site-specific assessments can be used to assess individual management practices or management measures, while watershed assessments can be used to look at the cumulative effects of implementing multiple management measures. Determination should be made as to which management measures should be evaluated, and a baseline should be established from which decisions can be made regarding the need for additional incentives for implementation of management measures.

A team of experts should be assembled to perform postharvest monitoring. Teams should include a state forester who is familiar with management practice standards for both implementation and effectiveness. Where possible, the survey team should be accompanied by the landowner on whose property the survey is being conducted, the logger who conducted the harvest, and the state forester who prepared the harvest plan, if applicable. Other experts could be specialists in fields such as watershed science, soil science, wildlife biology, hydrology, fishery management, or road engineering. Separate organizations might also be represented, such as environmental organizations or representatives of the timber industry.

If feasible, audits should be conducted soon after harvests are completed so that improvements can be made to management practices found to be inadequately implemented and to minimize the water quality impacts of those practices.

*Preharvest notification system:* A preharvest notification system should be established to assist in selecting an adequate and unbiased sampling population of harvest sites, to reduce the cost of site selection, and to help determine, prior to a site visit, that selected sites meet many of the selection criteria such as time since harvest and size of harvest. Harvest sites need to be chosen randomly. Stratification based on desired characteristics of sites is perfectly acceptable, but if this is done, sampling within the strata must be random to ensure the validity of results.

*QA/QC:* Quality assurance (QA) and quality control (QC) procedures should be implemented to ensure the accuracy of all analytical measurements made in postharvest evaluations. QA/QC procedures are cost-effective measures used to determine how to allocate project energies and resources toward improving the quality of research and the legal sufficiency of project results.

*Critical watersheds:* If the geographic extent of an audit includes a critical watershed, a separate statistically valid sample population should be created for the watershed and information from harvests within the watershed should not be grouped with information from other harvests. It is important to maintain separate information for watersheds that have been designated “critical” and to sample them separately if the information obtained is to be related to and useful for programs instituted to protect the watersheds.

### 2.2.13.3 Information Resources

- Numerous guidance documents have been developed, or are in development, to assist resource managers in developing and implementing monitoring programs that address all aspects of monitoring design. **Appendix A in *Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls*** presents a review of more than 40 monitoring guidance manuals for both point and NPS pollution. These guidance manuals discuss virtually every aspect of NPS pollution monitoring, including monitoring program design and objectives, sample types and sampling methods, chemical and physical water quality variables, biological monitoring, data analysis and management, and quality assurance and quality control (USEPA, 2002). This document is available through the National Service Center for Environmental Publications (Telephone: 800-490-9198).

- **Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures—Forestry** (<http://www.epa.gov/owow/nps/forestry/index.html>): Sampling design, approaches to conducting the evaluation, data analysis techniques, and ways to present evaluation results are described in this manual.
- **World Wildlife Fund and World Bank, *Running Pure*** (<http://www.panda.org/downloads/freshwater/runningpurereport.pdf>): This report provides insight on the benefits to urban populations of well-managed natural forests in terms of high quality drinking water.

#### 2.2.13.4 References

- CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.
- USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



**Fact Sheet Links:**

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

## 2.2.14 Management Measure 2L Education/Outreach

### *Management Measure*

Implement educational programs to provide greater understanding of watersheds, and to raise awareness and increase the use of applicable forestry management measures and practices where needed to control and prevent adverse impacts on surface and ground waters. Public education, outreach, and training programs should involve user groups and the community.

### 2.2.14.1 Programs

- The California Department Forestry and Fire Protection's Fire and Environmental Education Program consists of school programs, fair exhibits, posters, flyers and thousands of other printed materials, radio and television spots, community meetings, one-on-one contact with wildland homeowners, and a Web site (<http://www.fire.ca.gov/php/education.php>).
- The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. This State government program provides technical and financial assistance to influence positive changes to forest land management, assists communities in solving common watershed problems, and helps landowners in a number of ways. For assistance, call the Forest Stewardship Helpline (Telephone: 1-800-PET-TREE; Web site: <http://ceres.ca.gov/foreststeward/index.html>).

### 2.2.14.2 Management Practices

Education and training are vital to effective management practice implementation. Educating and training loggers and landowners about the importance and use of management practices is an effective way to reduce water quality effects from forest operations because harvesters and landowners are responsible for forest harvesting and decisions concerning the management of much of the forested land in the nation.

These programs are based on the premise that it is important to teach forest ecology and silviculture to loggers because professional foresters supervise less than a third of all the acres harvested in the United States while loggers are involved in all of the harvests. Before these programs existed, few people employed in logging had training in forestry and silviculture, and the logger education programs are changing that situation. To accomplish its goal, logger training emphasizes five areas—safety and first aid, business management, harvesting operations, professionalism, and forest ecology and silviculture (USEPA, 2002).

### 2.2.14.3 Information Resources

- **University of California Center for Forestry**  
(<http://www.cnr.berkeley.edu/forestry/information.html>): The Center provides leadership in the development of basic scientific understanding of ecosystem processes, human interactions and value systems, and management and silvicultural practices that ensure the sustainability of forest land in California. Location: 145 Mulford Hall #3114, University of California, Berkeley, Berkeley, CA 94720-3114 (Telephone: 510-642-0095; Fax: 510-643-3490).

- **California Forest Stewardship Program** (<http://ceres.ca.gov/foreststeward/>): The program is designed to encourage good stewardship of private forest land. The program provides technical and financial assistance to influence positive changes to forest land management, assists communities in solving common watershed problems, and helps landowners. It includes a Forest Stewardship Helpline (Telephone: 1-800-PET-TREE), a quarterly newsletter, programs that provide financial and technical assistance, demonstration projects, and a landowner curriculum. A calendar of natural resource events is updated regularly for information on conferences, workshops, and other programs for the public. Its Web site also provides contacts for technical assistance related to forest stewardship issues (<http://ceres.ca.gov/foreststeward/html/assistance.html>).
- **Forestry Institute for Teachers** (<http://www.forestryinstitute.org/>): This program educates K-12 teachers about how ecosystems and their management affect the needs of both rural and urban citizens about water, wildlife, recreation, biological diversity, habitat protection, and consumer products derived from forests. Teachers who participate in the program are able to share their understanding of forest ecology and natural resource management principles and concepts with their students.
- **Humboldt State University College of Natural Resources and Sciences, Institute for Forest and Watershed Management** (<http://www.cnr.berkeley.edu/forestry/information.html>): The Institute is dedicated to the acquisition, compilation, dissemination, and application of knowledge about the sustainable management of ecological systems in Northern California (Telephone: 707-825-7350).
- **Northern California Society of American Foresters** (<http://norcalsaf.org/>): This organization provides forums for professional development and community outreach.
- **Southern California Society of American Foresters** (<http://www.socalsaf.org/>): This organization provides forums for professional development and community outreach.
- **Registered Professional Forester Program** ([http://www.fire.ca.gov/CDFBOFDB/pdfs/Role%20of%20RPF\\_2002%20ygeditfinal\\_.pdf](http://www.fire.ca.gov/CDFBOFDB/pdfs/Role%20of%20RPF_2002%20ygeditfinal_.pdf)): A registered professional forester (RPF) is a person knowledgeable in a wide range of studies such as biology, ecology, entomology, geology, hydrology, dendrology, silviculture, engineering, business administration, forest economics, and other natural resource subjects. RPFs use their well-rounded education and experience to maintain the sustainability of forest resources like timber, forage, wildlife, water, and outdoor recreation to meet the needs of the people while protecting the biological integrity and quality of the forest environment.
- **University of Wisconsin Cooperative State Research, Education, and Extension Service, Best Education Practices Project** (<http://wateroutreach.uwex.edu/>): The University of Wisconsin Cooperative State Research, Education, and Extension Service has initiated the Water Outreach Education project, also known as the Best Education Practices project, to help natural resource management and outreach professionals to choose appropriate education techniques and resources for their water management programs. The Best Education Practices project will work in collaboration with the federal agency clean and safe water partnership and other networks to develop and promote best education practices for water education and to improve access to education resources and strategies. Project activities reflect advice provided by federal agency clean and safe water partners and a national network of water education organizations created and supported by the work of several national organizations over the last decade. Projects have included a 2002 Study of Provider Needs, Model Education Technique, a literature search, Best Education Practices Pilot Web site, and other reference materials related to water outreach education.

- **USEPA Watershed Academy Web site** (<http://www.epa.gov/watertrain/>): This Web site offers 50 self-paced training modules that represent a basic and broad introduction to the watershed management field. The module themes include introduction/overview, watershed ecology, watershed change, analysis and planning, management practices, and community/social/water law. Two forestry-related modules are available: “Forestry Best Management Practices in Watersheds” (<http://www.epa.gov/watertrain/forestry/>) and “Applying Ecological Principles to Management of the U.S. National Forests” (<http://www.epa.gov/watertrain/step6esa.html>).

#### 2.2.14.4 Case Study

*Stewardship Education for Forest Landowners*: The Extension Forestry group of the California Forest Stewardship Program has developed a comprehensive curriculum on forest ecology and management. The target user for this curriculum is the nonindustrial forest landowner who owns parcels of forest land but who is not in the commercial timber production business for a livelihood. The topics covered in the curriculum are organized around the themes of “who, where, what, when, how, why, and how much” and cover virtually all aspects of land ownership and management ranging from mapping through taxation and investment analysis. Existing sources were used and new documentation prepared to round out the information base. In the summer of 2001 some of the materials were used at a 3-day workshop for landowners held in Redding, and the exposure was valuable for improving the presentations. More information about the forest landowner curriculum is available at <http://ceres.ca.gov/foreststeward/html/curriculum.html>.

#### 2.2.14.5 References

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.